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A study on soil fertility status of adopted model village in Rahuamani, Kahra block of Saharsa district in Bihar

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Abstract

Soil fertility assessment in a region is the most basic decision-making tool for sustainable soil nutrient management. A soil fertility status inventory work was carried out in adopted model village, Rahuamani of Kahra block in Saharsa district. One hundred soil samples were randomely collected based on the handled GPS location. Results showed that 91% samples were found in neutral reaction and all the samples fall under normal and safe category of electrical conductivity. Sixty-five per cent soil samples fall under lows organic carbon content and 35% samples were medium in organic carbon content. 61% of the study area was deficient in available N and 81% samples were fall under medium category of fertility status of P_5O_5. The available potassium content in soil, 90% of the soil samples were medium fertility level. It was found that 75% samples were in medium soil sulphur category. Zn content of the study are fall under the medium fertility category. Similarly, 58% sample deficient in copper content and 47% sample are deficient in available Mn. Out of total soil sample analyzed 78% samples are deficient in B content in soil.

Keywords: Fertility Status; Evaluation; Agro-climatic zone; Kahra block

1. Introduction

In any agricultural operation, soil is the utmost importance as it is the cradle for all crops and plants. This is the resolve of nutrients that play an important role in supplying the growth of crops and other vegetative keeping the environment clean [1]. In India, the limit soil resources available for agriculture are shrinking and optimizing the utilization of these resources with intensification of agriculture resulted in the fast depletion of nutrients. It is therefore important to regularly monitor the fertility status of soil from time to time with a view to sustain the soil health [2].

Soil fertility fluctuates throughout the growing season due to alteration in the quantity and availability of mineral nutrients by the addition of fertilizers, manures, compost, mulch in addition to leaching [3].

A present nutrient mining is a great thread to Indian agriculture as there is a wide gap between nutrient addition and nutrient removal. Indian agricultural is operating on a net negative balance of plant nutrients at the rate of 10 million tonnes (Mt) per annum [4]. One of the reasons for lower production is imbalanced use of fertilizers by the farmers without knowing soil fertility status and nutrient requirement of crops causes adverse effect on soil and crop both in term of nutrient toxicity and deficiency [5]. The deficiencies are so intense and serve that visual symptoms are very often observed in major crops. Hence, evaluation of fertility status of the soil of an area or a region is an important aspect in the context of sustainable agriculture [6]. Soil testing which forms the basis of the fertilizer recommendation for maximizing crop yield and further to maintain the optimum fertility in soil year after year [7].

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2. Material and methods

The study was conducted in Rahuamani village which is lies between 25º89’40” E longitude and 86º58’65” N latitude of agro-climatic zone-II of Bihar at an elevation of 49 m above the sea level. The climate of the area is semi humid and receives annual rainfall of about 1100 mm and have an average annual temperature of 25.5 ºC. Rahuamani village under the Kahra block of Saharsa district was adopted by Mandan Bharti Agriculture College, Agwanpur, Saharsa to transform it into model village. The ideal village model is based on multidimensional aspects including agricultural issues. The village identified various issues including absence of scientific management of nutrients, improper land use and crop diversification.

The Koshi river and its tributaries flood annually affecting about 21,000 square kilometre of fertile agricultural land and affecting the rural economy. The area has been cultivated for a diverse range of crops such as maize, wheat, rice, gram, makhana, vegetables and mango. Total 100 random surface soil samples were collected from the study area based on handheld GPS device (Garmin make, model: 76 MAPCSX). The collected soil samples were air dried, ground with wooden pastel and mortar and sieved through 2 mm sieve (0.2 mm sieve for organic carbon) labelled and stored. The samples were analyzed for chemical parameters viz., pH and EC [8], organic carbon [9], available nitrogen [10], available phosphorus [11], available potassium [12], available boron [13] and available Zn, Cu, Fe and Mn [14].

3. Results and discussion

3.1. Soil reaction (pH)

The soil reaction of the study area varied from 6.0 to 7.9 in a very narrow range with mean value of 6.95 and 91% of samples were found in neutral reaction and 7% & 2% samples were found in acidic and saline reaction, respectively (Table-1).

Table 1 Distribution of soil samples under different pH rating

Classes	Range	No. of Samples	% of Samples
Acidic	< 6.5	07	07
Neutral	6.5 – 7.5	91	91
Alkaline	7.6 – 8.5	02	02

3.2. Electrical Conductivity

The electrical conductivity of the soil water suspension ranged from 0.22 to 0.37 dSm^{-1} in soils of study area with a mean value of 0.29 dSm^{-1}. All the soil sample (100%) fall under normal and safe category (Table-2). The low EC may be due to free drainage conditions which favoured the removal and release of bases by percolating and drainage water [15].

Table 2 Distribution of soil samples under different electrical conductivity rating

Classes	Range (dSm^{-1})	No. of Samples	% of Samples
Low	< 1.0	100	100
Medium	1.0 – 2.0	00	00
High	2.0 – 3.0	00	00

3.3. Organic carbon

The organic carbon content in study area ranged from 0.39 to 0.62 with a mean value of 0.50%. From all collected soil samples 65% samples fall under low and 35% falls under medium fertility category (Table-3). It may be ascribed due to low input of FYM and crop residue as well as rapid rate of decomposition [16].

Table 3 Distribution of soil samples under different organic carbon rating

Classes	Range (%)	No. of Samples	% of Samples
Low	< 0.50	65	65
Medium	0.50 – 0.75	35	35
High	> 0.75	00	00

3.4. Available Nitrogen

Available nitrogen content in soil of Rahuamani village ranged from 103 to 196 kg ha^{-1} with mean value of 149.50 kg ha^{-1} (Table-4). It has been revealed that 60% of the study area was deficient in available nitrogen. It may be ascribed to the nitrogen is lost through various mechanism like ammonia volatilization, nitrification, chemical and microbial fixation, leaching, runoff and these soil had a very low content of organic carbon [17].

Table 4 Distribution of soil samples under different available nitrogen rating

Classes	Range (Kg ha^{-1})	No. of Samples	% of Samples
Low	< 280	60	60
Medium	280 – 560	40	40
High	> 560	00	00

3.5. Available Phosphorus

Available phosphorus content in the study area found to be varied from 8.96 to 17.32 kg ha^{-1} with a mean value of 13.14 kg ha^{-1}. It has been revealed from the table-5 that 18% samples falls under deficient category and 82% samples in medium category of phosphorus content. It might be due to organic matter content and various soil management and agronomic practices [18].

Table 5 Distribution of soil samples under different available phosphorus rating

Classes	Range (Kg ha^{-1})	No. of Samples	% of Samples
Low	< 10	18	18
Medium	10 – 25	82	82
High	> 25	00	00

3.6. Available Potassium

The available soil potassium content were found to be vary in between 98 to 278 kg ha^{-1} with a mean value of 188 kg ha^{-1}. Among all the collected soil samples 90% samples were found under medium and 10% samples were fall under the category of deficient (Table-6).

Table 6 Distribution of soil samples under different available potassium rating

Classes	Range (Kg ha^{-1})	No. of Samples	% of Samples
Low	< 110	10	10
Medium	110 – 280	90	90
High	> 280	00	00

3.7. Available Sulphur

Available sulphur status was found to be ranged between 10.25 to 22.16 kg ha^{-1} with an average value of 16.20 kg ha^{-1}. It was found that 75% of the sample collected from the study area 75% were falls under the category of medium fertility status and 25% samples were deficient in sulphur content. Deficiency of soil S might be due to the presence of variable properties of different components of organic matter, soil and crop management practices, water use and addition of fertilizer [19].

Table 7 Distribution of soil samples under different available sulphur rating

Classes	Range (mg Kg^{-1})	No. of Samples	% of Samples
Low	< 10	25	25
Medium	10 – 20	75	75
High	> 20	00	00

3.8. Available Boron

Hot water extractable B content of the study area varied in between 0.21 to 1.0 mg kg^{-1} with a mean value of 0.60 mg kg^{-1}. Out of 100 soil samples collected from the study area; 78% samples were deficient in B content and 22% samples were fall in the category of medium fertility status.

Table 8 Distribution of soil samples under different available boron rating

Classes	Range (Kg ha^{-1})	No. of Samples	% of Samples
Low	< 0.50	78	78
Medium	0.50 – 1.0	22	22
High	> 1.0	00	00

3.9. DTPA extractable micronutrients

Available Fe content in the study area found to be ranging from 2.9 to 11.23 mg kg^{-1} with a mean value of 7.06 ppm. The data in the table-9 revealed that 25% soil samples were fall under the category of high, 17% soil samples fall in low category and 58% soil samples were fall under the category of medium fertility.

Table 9 Distribution of soil samples under different available iron rating

Classes	Range (mg kg^{-1})	No. of Samples	% of Samples
Low	< 4.5	17	17
Medium	4.5 – 9.0	58	58
High	> 9.0	25	25

Available zinc content in all the 100 soil samples revealed that 39% of the samples were deficient and 18% samples were in sufficiency range whereas 53% samples falls in the category of medium fertility (Table-10).

Table 10 Distribution of soil samples under different available zinc rating

Classes	Range (mg kg^{-1})	No. of Samples	% of Samples
Low	< 0.78	39	39
Medium	0.78 – 1.20	53	53
High	> 1.20	18	18

The content of copper in the soil samples of the study area has been presented in table-11. It varies between 1.01 to 4.80 mg kg^{-1} with a mean value of 2.90 mg kg^{-1}. Out of total 100 soil samples 58% are deficient, 2% are sufficient and 40% falls in the category of medium fertility.

Table 11 Distribution of soil samples under different available copper rating

Classes	Range (mg kg^{-1})	No. of Samples	% of Samples
Low	< 0.60	58	58
Medium	0.60 – 1.20	40	40
High	> 1.20	02	02

Table 12 Distribution of soil samples under different available manganese rating

Classes	Range (mg kg^{-1})	No. of Samples	% of Samples
Low	< 3.00	47	47
Medium	3.00 – 5.00	40	40
High	> 5.00	13	13

Out of 100 soil samples analyzed 47% are deficient in Mn, 13% are in the category of sufficiency and 40% falls in the category of medium fertility.

Figure 1 Map of Saharsa District

Since, most of the soils sample are low in medium category of soil micronutrient availability, the addition of micronutrient fertilizer, in integration with organic manure and biofertilizer and recommended to enrich the micronutrient availability to the crops.

4. Conclusion

Soils of the Rahuamani village were neutral in reaction. However all soil samples were at the safe limit for electrical conductivity. Most of the soil samples have low to medium organic carbon content. These soils have low to medium available N, P, K and S. the soils are deficient in boron, low to medium in available zinc. Majority of the soil samples observed copper and manganese deficiency in the study area and iron content was medium to high. Hence, 25% more fertilizers than that of the recommended dose should be applied in the plots having lower range of nutrients. In case of the plots having high status of nutrients, 25% less fertilizers than that of recommended dose should be applied. In the rest of the plots having medium range recommended dose of fertilizers should be applied. Application of organic manure along with inorganic will not only help in enriching the soil with organic matter but also will be a key for sustaining soil health and quality. Consequently, soils requires attention with regards to nutrient management practices and regular monitoring of soil health to increase yield.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflicts of interest.

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